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Two-point velocity statistics from ocean surface drifter observations in the Benguela upwelling system

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Albeit Lagrangian trajectories from surface drifters in the ocean constitute a time evolving, highly non-uniform spatial grid, the drifter velocity observations can be treated as scattered point Eulerian measurements. These scattered measurements can be used to estimate the two-point velocity statistics, which can help in deducing the turbulent properties of the flow: e.g. the scale-dependent distribution of kinetic energy [1] and spectral fluxes [2].

Here we examine the probability distribution of relative longitudinal velocity, as a function of spatial separation, from surface drifters deployed in triplets at the boundary of a filament in the upwelling region off Namibia. For the drifters released at the northern boundary of the filament, close to the upwelling region, we find the PDF to be positively skewed (3^{rd} order structure function) for relative separations of $10\ \mathrm{km} - 80\ \mathrm{km}$, supporting former findings of an inverse energy cascade (Richards scaling of pair separations) [3]. For the drifters released at the southern boundary, we find the 2^{nd} order structure function (variance) follows a $2/3$ power law for relative separations of $1\ \mathrm{km} - 800\ \mathrm{km}$. This shallow power law, although reminiscent of Kolmogrov turbulence, points to potentially a few different possible underlying dynamics in the oceanographic context : mixed layer baroclinic instability [4], linear internal waves [5] or nonlinear internal waves/stratified turbulence [6]. We also perform a Helmholtz decomposition, to glean more into the dynamical origin of this scaling behavior.

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